SOIL HORIZON DEPTH CORRECTION BASED ON SLOPE GRADIENT

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Program Title:

Soil Horizon Depth Correction Based on Slope Gradient

Calculator:

Hewlett-Packard HP-67, HP-97, and HP-55

Program Description:

Alexander (1977) has discussed some reasons for reporting depths of soil horizons on steep terrain, as distances that are perpendicular to the soil surface. In brief, soil horizons usually develop parallel to the land surface. On steep slopes (figure 1) the differences between vertical measurements (length C) and perpendicular measurements (length B) can be important in management interpretations and taxonomic classification. Water holding capacity and other soil properties based on soil volume will be overestimated when vertical rather than perpendicular measurements are used. Many taxonomic classifications are based on soil depth and thickness measurements and therefore can be affected by the way the measurement is made.

This procedure can be used to adjust vertical depth measurements to distances that are perpendicular to a soil surface. A slope gradient, in percent, is entered into this program, then any number of vertical depths for the given slope, can be transformed to depths perpendicular to the surface.

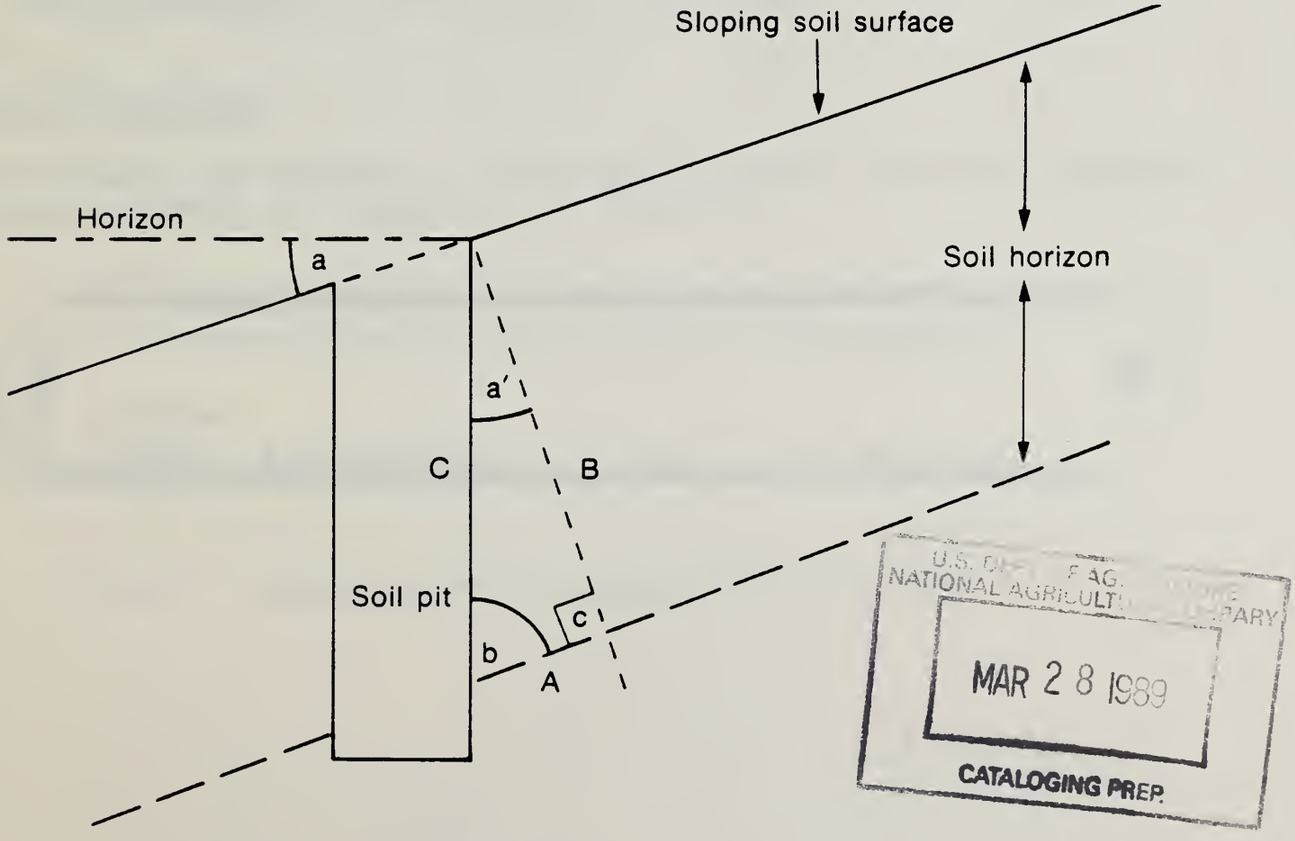

Figure 1. Geometry for correcting a vertical measurement to depths perpendicular to a surface.

Analytical Procedure:

This problem involves finding the length of side B (Figure 1), given angle "a" and length of side C. From basic geometry, angle a (slope of soil surface) = angle a'. Angle c = 90°.

1. Determine the slope angle in degrees given percent slope.

   Slope (degrees) = Arctan (slope % / 100)

2. Calculate length of side B (corrected horizon depth) given length C (uncorrected horizon depth).

   Length B = Length C x cos of angle a (degrees)

Remarks:

Any calculator with trigonometry functions can be used.

Operating Limits: None identified.

References:

Alexander, E.B. 1977. Measurement of soil depths and horizon thicknesses. Soil Surv. Horiz. 18:9-11.
User Instructions: (HP-67, HP-97, and HP-55)

Program Procedures:

The following instructions are for an HP-67 or HP-97 after this procedure has been recorded on a magnetic card (Figure 2).

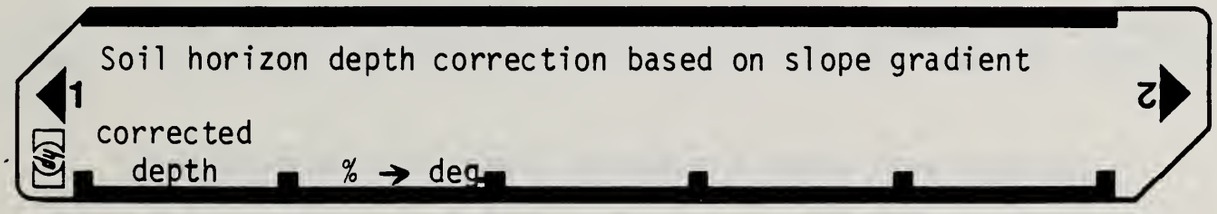

Figure 2. Labeled magnetic card for HP-67 and HP-97.

HP-67, HP-97 User Instructions:

Step	Instruction	Input Data/Units	Keys	Output Data/Units
1.	Load program card, side 1	---	---	---
2.	Input percent slope gradient	%	B	cos of angle a
3.	Input soil horizon depth	in,ft,cm,m	A	in,ft,cm,m
4.	Repeat step 3 for all depths with slope input in step 2			
5.	For a new slope gradient go to step 2.			

HP-55 User Instructions:

Step	Instruction	Input Data/Units	Keys	Output Data/Units
1.	Set calculator to PRGM.			
2.	Load program steps.			
3.	Set calculator to RUN.			
4.	Press BST.			
5.	Input percent slope gradient.	%		
6.	Press R/S to start execution		R/S	cos of angle a
7.	Input soil horizon depth.	in,ft,cm,m		
8.	Press R/S to start execution.		R/S	in,ft,cm,m
9.	Repeat steps 7 and 8 for all depths with slope input in step 5.			
10.	For a new slope gradient go to step 4.			

Example Problem:

A soil on a 45 percent slope has three horizons with vertical depths as follows: (1) Horizon A: 0-18", (2) Horizon B: 18-27", and (3) Horizon C: 27-36".

Load program card side 1 or enter program from keyboard

Keystrokes		Press HP-67, HP-97	Press HP-55	Displayed Outputs
Enter				
45	slope %	B	R/S	0.91 (cos angle a)
18	depth of B horizon	A	R/S	16.41 (corrected depth)
27	depth of C horizon	A	R/S	24.62 (corrected depth)
36	bottom of pit	A	R/S	32.83 (corrected depth)

Program Listing:

The following program listings are for an HP-97 (Figure 3) or an HP-55 (Figure 4). Please refer to an appropriate owners manual for a listing of keycodes and corresponding keystrokes. A flow chart (Figure 5) shows the program logic.

Step	Key Entry	Key Code	Comments
001	*LBLB	21 12	Convert percent
002	1	01	slope gradient to
003	0	00	degrees.
004	0	00	
005	$\div$	-24	
006	TAN^{-1}	16 43	
007	COS	42	Cos of angle a.
008	STOA	35 11	
009	RTN	24	Calculate perpen-
010	*LBLA	21 11	dicular distance.
011	RCLA	36 11	
012	X	-35	
013	RTN	24	

Registers Used: A

Labels Used: A, B

Flags Used: None

Set Status:

Trig. mode = degrees, Display format = fixed Displayed decimal places = 2

Figure 3. Program listing for HP-67 and HP-97.

Press BST in RUN mode, switch to PRGM mode then key in program.

Display Line	Display Code	Key Entry	Comments
00			
01	01	1	Convert percent
02	00	0	slope gradient to
03	00	0	degrees.
04	81	$\div$	
05	32	g	
06	14	TAN^{-1}	
07	31	f	cos of angle a.
08	13	COS	
09	33	STO	
10	00	0	
11	84	R/S	calculate perpen-
12	34	RCL	dicular distance.
13	00	0	
14	71	x	
15	-15	GTO 11	

Registers Used: 0

Display Format: FIX 2

Figure 4. Program listing for HP-55.

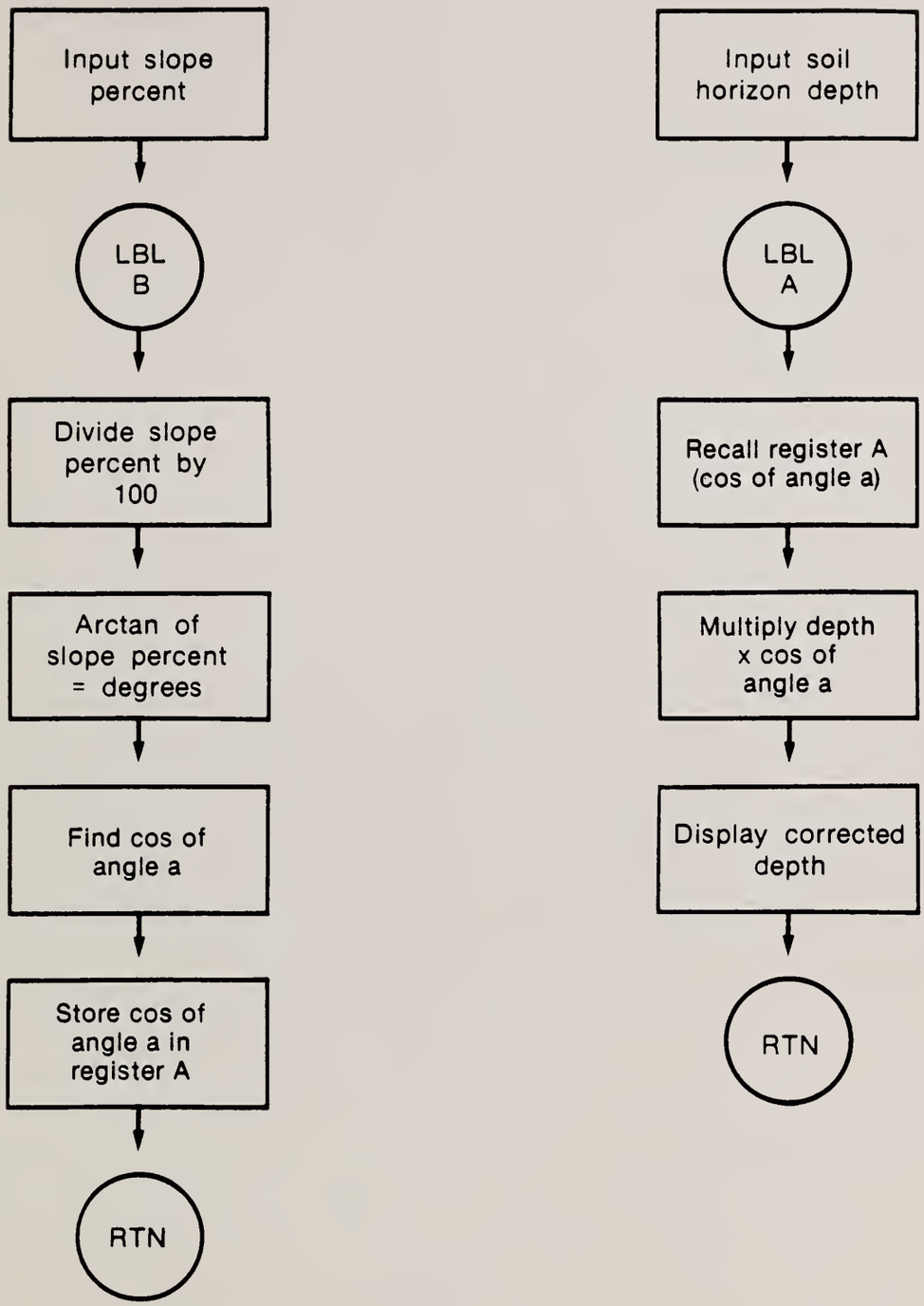

Figure 5. Flow Chart of program logic for computing soil horizon depth correction due to slope gradient. LBL and RTN are HP-67 and HP-97 program keys which start and terminate execution.